RESETTLEMENT ADMINISTRATION
Division of Land Utilization

Region VII
Lincoln, Nebraska

# SLENDER WHEATGRASS

for

# THE NORTHERN GREAT PLAINS



By

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# FOREWORD

This compilation of information concerning slender wheatgrass is the fourth and last of a series of reports covering the grasses which seem to hold most promise for use in regrassing farm land in the Northern Great Plains. Crested wheatgrass, western wheatgrass, and bromegrass are the other species for which data have been compiled by this office. Inasmuch as readers presumably have access to the other reports, this account is somewhat less inclusive of details. Nevertheless, a certain amount of almost unavoidable repetition will be found. The grasses can not be compared and evaluated without making use of much of the same material in discussing the merits of each.

Like the others, this report is based essentially on the literature cited. It embodies no original field research on the part of the author, but is merely an attempt to collect information from all available sources and assemble it in usable form. In general, there is a greater dearth of definite information relative to the use of this grass in the northern plains than is the case with crested wheatgrass and bromegrass. This has made it necessary to infer more by comparison, and to depend more on widely scattered and fragmentary references than is desirable. Although subsequent experience may dictate some modification of the inferences and conclusions stated herein, it is believed that they are essentially sound in the light of the published data. The discussion should be useful, at least as a tentative guide, in determining the place of the species in a planting program for the Northern Great Plains.

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# INTRODUCTION

Slender wheatgrass, or western rye grass, (Agropyron pauciflorum (Schwein.) Hitchc., A. tenerum Vasey) was the first native American forage grass to be domesticated, and shares with reed canary grass (Phalaris arundinacea) the distinction of being the only American grasses now under cultivation. Various other species have been grown artificially, and attempts at domestication have been made, but without success. Though it is possible that western wheatgrass (Agropyron smithii) may soon join the ranks of American cultivated grasses, it can scarcely be placed in that category at the present time.

Slender wheatgrass was first cultivated in 1885 by a Mr. McIvor at Virden, Manitoba, and soon after was tested and distributed by the Dominion Experimental Farm at Brandon. It is of interest that at about this same time (1884) bromegrass was introduced into the United States. Until the advent of crested wheatgrass (Agropyron cristatum) in American agriculture, the Canadian prairie provinces had remained the seat of the greatest interest in slender wheatgrass; bromegrass has generally found more favor in the northern plains region of the United States. Agriculturists of both nations now generally proclaim crested wheatgrass as the forage grass par excellence for the arid northern plains. The general conclusion to be derived from the literature in regard to grass species suitable for range and pasture planting in this region is that crested wheatgrass ranks first, bromegrass second and slender wheatgrass third. Some Canadians possibly would reverse the positions of the latter two species. The relative usefulness of western wheatgrass remains to be determined.

However, the supply of crested wheatgrass seed is limited, and quite probably it will be scarce and high-priced for several years to come. In any extensive program for regrassing abandoned farm lands, other species must, of necessity, be utilized to a considerable degree. Slender wheatgrass has desirable features, some seed is available, and its cultural requirements are fairly well known. Hence, it will have a place in a planting program. The purpose of this report is to summarize the available information concerning the species, that it may be utilized to the best advantage.

## HABITS OF GROWTH

Slender wheatgrass is pre-eminently a bunch grass and very rarely shows any tendency to produce rootstocks or rhizomes. In this respect it is most closely allied to crested wheatgrass. Western wheatgrass and bromegrass have the rhizome habit strongly developed and thus form compact sods. Under favorable conditions, slender wheatgrass produces a few rootstock (25)*, but spreads mostly by tillering. The bunches range in size up to 1 foot in diameter. The foliage is never profusely leafy, and after flowering, is relatively stemmy. Flower stalks, 2 to 4 feet high, are produced in abundance. The inflorescence is a slender and compact spike 2 to 4 inches long. Normally, the species seeds prolifically.

Slender wheatgrass is one of the earliest native grasses to start growth in the spring. It starts about the same time as bromegrass, which is 1 to 2 weeks later than crested wheatgrass, but still a week or more in advance of most of the native species. In the mountain grazing lands of Colorado, the renewal of growth is evident in early March (10). At Mandan, North Dakota, the same general relation between the starting dates of the various grasses holds, but all renew growth about 1 month later (early April) (37). In the Matanuska region of Alaska, slender wheatgrass is reported to start somewhat later than brome (1). No specific comment has been seen relative to late fall growth. Nelson (23) noted that, at Laramie, Wyoming, some aftermath was produced in October after the grass had entirely dried up in September. It is inferred from discussions of the species that its cycle of development coincides roughly with that of most other native grasses of the northern plains. In general, this means that its growth is influenced most by May and June rainfall, flowering attains its peak in July, and maturity occurs in August. When the latter part of the summer is dry, maturity is hastened, and the grass becomes dormant until revived by fall rains. It is the earliest of the important native wheatgrasses to mature at Laramie, Wyoming (23). According to Kirk (17), the seeds and herbage mature simultaneously in slender wheatgrass, whereas the foliage of crested wheatgrass remains green after the seed are ripe. Consequently, when grown for seed, the threshed straw of slender wheatgrass is inferior to that of crested wheatgrass for feeding purposes.

One of the desirable features of slender wheatgrass is the relatively rapid development of the seedlings (2, 5, 6). In a favorable year, some pasturage or a light hay crop may be harvested the year of seeding. On the other hand, stands are rather short-lived (2, 17, 37). Production tends to decline after 4 or 5 years, and unlike bromegrass, stands can not be rejuvenated by cultivation. Hence, the species is most useful in mixture with slow-growing, but more permanent grasses. The slender wheatgrass makes prompt growth while the other species are becoming established, and is later supplanted by them.

* Numbers in parentheses refer to "Literature Cited", page 18.

## VARIETIES

Apparently, more breeding work has been done with slender wheatgrass than with any other perennial dry-land grass. This may be ascribed to the following factors: (a) The species is highly variable, with a great number of forms and intergrading types occurring in nature (7, 16, 20). (b) The flowers normally are self-fertilized, hence selections breed true to type and can be isolated and multiplied much more readily than cross pollinated species. Slender wheatgrass is unique among cultivated grasses in this respect (16, 20). (c) The continued interest of Canadian agriculturists in the possibilities of the grass as a forage crop.

An excellent account of the breeding work with this plant is given by Kirk (16). The first named strain, called "Grazier" was developed by the Dominion Experimental Farms and distributed in the early 1920's. In 1925, an improved strain called "Fyra" was distributed by the Field Husbandry Department of the University of Alberta. At the time of Kirk's writing (1929), a strain called "Mecca" was showing great promise at the University of Saskatchewan, and was to be distributed the following year. Under test, this strain gave yields of both hay and seed of as much as 37 per cent over commercial stock. Further work was reported to be under way at several stations in Canada, with promise of other highly productive lines to appear later. This work probably has been curtailed in recent years, due to interest in crested wheatgrass. No report has been seen of the distribution of other named varieties of slender wheatgrass since 1929.

Commercial seed houses ordinarily do not list specific varieties of this grass. Presumably they are handling only common mixed stock. However, in view of the reported superiority of these named varieties, it would appear worth while to obtain them, if possible, for planting purposes. The experiment stations and agricultural colleges in both Canada and the United States doubtless can help in obtaining this seed when needed.

## DISTRIBUTION AND ADAPTATIONS

Distribution. Slender wheatgrass is the most widely distributed native Agropyron. It attains its best development northward, ranging from Maine westward to the Pacific slope, and northward throughout the prairie provinces of Canada and into Alaska. It is found as far south as northern Kansas in the plains, and extends into New Mexico and Arizona at higher elevations. It is common in dry mountain meadows at medium elevations throughout the west (27). It is reported to be one of the commonest grasses in river bottoms in Wyoming (23). In the Dakotas, it is not listed among the most important constituents of the native vegetation, and is said to occur usually in places where the prairie sod is more or less broken and open (36). It is relatively unimportant among the prairie grasses in Nebraska, but when present, tends to occur in pure stands (15).

Climatic Adaptations. The natural distribution of slender wheatgrass indicates its climatic adaptations. It is pre-eminently a grass of the Northern dry plains and of mountain meadows. It will be most useful in those regions. Although it occurs naturally farther east, other species are generally more suitable east of the Mississippi River (25). Its adaptability declines with higher temperatures southward; consequently it is of limited value in Kansas and the adjacent plains in Colorado (31). It has not proven particularly useful in Nebraska, but shows some promise in the northern and western parts of the state where increased elevation and latitude temper the summer heat (4, 30).

All reports indicate that it is completely hardy to cold, and ranks high in drought endurance (10, 22, 25, 31, 38). Recent literature indicates that crested wheatgrass is more productive under extremely dry conditions, and there is considerable evidence that bromegrass, also, is superior in this regard. However, numerous instances are recorded where slender wheatgrass has outyielded bromegrass, and occasionally, crested wheatgrass as well. As Nelson (23) has pointed out, for every plant there is an optimum condition of soil, moisture, and temperature. Very rarely is the optimum attained - it is only approximated - but the more closely that optimum for a given species is approached, the better will be its development, and the greater the liklihood of its surpassing other species growing under the same conditions. Many of the discrepancies in results from different stations doubtless are due to local differences in soils, seasonal and regional climatic variations, or differences in cultural methods oftentimes so elusive that they escape ready detection. In general, the drought resistance of slender wheatgrass, when evaluated from yields, tends to fall below that of bromegrass and crested wheatgrass in the northern plains region of the United States. Dillman (5, 6) states that it is inferior to both bromegrass and western wheatgrass in this respect. The differences between slender wheatgrass and bromegrass tend to be minimized, or may even be reversed in more northern latitudes. In the Matanuska Valley of Alaska, slender wheatgrass is reported to be distinctly superior to brome in endurance of drought (1).

Kirk (17) made comparative examinations of the root development of crested wheatgrass and slender wheatgrass. He reports that the root systems of the former possessed more than twice as much dry matter, the main root mass extended twice the depth, and the system of fibrous roots was much more extensive. Love and Hanson (19) have shown that the root system of bromegrass is almost as well developed as that of crested wheatgrass. Hence, with respect to underground parts, slender wheatgrass is not so well adapted to dry soils as are these other species.

Soil Adaptations. Slender wheatgrass is best adapted to light, well drained, sandy soils (23, 27). Piper (25) states that "in nature it grows most abundantly in the alluvial lands along streams and only occasionally on the higher bench lands." Christ (3), referring to northern Idaho, says "it is well adapted for dry gravelly sites". With regard to soil preferences, it is in marked contrast to western wheatgrass, which thrives best on clays and heavy loams of the gumbo type. Both species, however, demand fair drainage and can not long tolerate saturated conditions (25). Nelson (23) comments on the fact that many fine wheatgrass meadows have been irrigated out of existence in the valleys of Wyoming by too continuous flooding.

Slender and western wheatgrasses also agree in possessing a high degree of alkali tolerance. Authorities are generally agreed that no important forage plant equals western wheatgrass in this respect. Slender wheatgrass will tolerate soil alkali concentrations as high as 0.8 per cent (based on dry weight of soil), and is rated by Kearney (14) below bromegrass, tall meadow oat, and meadow fescue. Crested wheatgrass did not figure in Kearney's studies. Kirk (17) observed the growth of slender wheatgrass, crested wheatgrass and bromegrass on alkali soil, and rated the tolerance of these three species in the order named. The reaction of plants to alkali is subject to several variable factors, hence the discrepancy between these observations is not surprising. The alkali problem is discussed in somewhat greater detail in the report on bromegrass issued by this office; for a more thorough treatment, the original paper by Kearney should be consulted.

## CULTURE

The culture of slender wheatgrass is essentially similar to that of crested wheatgrass and bromegrass, which species have been treated in separate reports from this office. Consequently, the following discussion duplicates some points regarding general procedures.

Preparation of Seed Bed. As with all crop plants, the chances of success in seeding are in proportion to the care with which the seed bed is prepared. Small seeded plants, such as the forage grasses, alfalfa, and the clovers, are most exacting in this connection. The seeds of slender wheatgrass, though not as small as those of some other cultivated plants, require rather ideal conditions for successful germination and the establishment of the seedlings. The seed bed should be fine, firm, mellow, moist, and free from weeds. In practice, seeding grasses after an inter-tilled crop usually provides good soil conditions and is economical. When plowing is done in preparation for planting grasses, it should precede the seeding date by several weeks or months to allow the soil to settle and restore the capillary connections with the subsoil. Fall plowing for spring sowing ordinarily is to be recommended. The amount of surface cultivation necessary to bring about good tilth and control weeds will depend on local conditions.

In localities where there is danger of soil blowing, plowing followed by prolonged exposure of the loose, bare soil to the wind obviously is undesirable. Under such circumstances, some rapidly growing plant drilled in widely spaced rows will help to hold the soil until the grass can be seeded and can produce an effective cover. For this purpose wheat or rye probably would be best for planting in the fall; in the spring sorghums might be used.

Seeding abandoned cultivated land without seed bed preparation may succeed in favorable years but always will be a rather uncertain venture. The economic feasibility of this procedure for the extensive regrassing of cultivated lands remains to be determined. As has been noted in the report on bromegrass, the cooperative experiments of the Northern Rocky Mountain Forest and Range Experiment Station in Montana are most pertinent in this connection. Various forage plants are being tried on abandoned cultivated dry land in an attempt to determine if reseeding methods consonant with the low value of the land can be developed. In most cases,

drilling was done with no preparation of the soil except to burn the weeds where necessary. Preliminary results indicate success, according to range reseeding standards, on 35 or 40 per cent of the acreage sown. Some of this seeding was done in the fall of 1933 and the spring of 1934, thereby encountering one of the most severe droughts ever recorded in the state. Any success whatsoever is encouraging in the light of these conditions. Though crested wheatgrass is giving the best results in these trials, slender wheatgrass is listed among the more promising species for the region (13).

Some experiments in reseeding abandoned cultivated land without seed bed preparation are being carried on at the Dominion Range Experimental Station in Alberta, which is in the driest part of western Canada. Various grasses and legumes were sown by broadcasting, then disced once to cover the seed. The field was open to grazing. In this test, only crested wheatgrass became established; slender wheatgrass was among the failures (17).

Time of Seeding. Early spring (April-early May) seeding generally is recommended for the Northern Great Plains. Fall seeding is considered better than late spring. The most important factor, of course, is the amount of available soil moisture. Plans for seeding must be adjusted to the seasonal conditions. When planting isdone in the fall, it must be borne in mind that small young seedlings are subject to winterkilling. Hence, seeding should be done sufficiently early (August-early September) to permit the plants to become well established, or else delayed late enough to prevent germination until spring.

Methods of Seeding. Since the seeds of slender wheatgrass are of sufficient size and weight to feed readily through an ordinary grain drill, that method of sowing is to be recommended. Drilling insures more uniform distribution and coverage of seeds than any other procedure. Any of the various types of seeders may be used, or the seed may be broadcast by hand. These methods require subsequent harrowing or discing to cover the seed. Harrowing ordinarily is practiced on prepared soil; discing gives better coverage on land that is weedy, covered with stubble, very compact, or otherwise unprepared. Whether or not the inefficiency of the latter methods will be compensated by greater economy is a matter to be determined by local conditions.

Nurse crops are not recommended in the northern plains under ordinary circumstances. In general, their beneficial effects are more than counterbalanced by the resulting competition. Their use may be justified on land that is inclined to blow, or they may be of value in controlling weeds on badly infested areas. When a nurse crop is deemed advisable, any of the cereal grains or flax may be used. The latter is in some respects preferable, in that it sets up less vigorous competition. Nurse crops should be sown at about one-half the usual rate of seeding.

Depth of Seeding. The seed should be planted as shallowly as is consistent with conditions of soil moisture. Ordinarily, depths of 0.5 to 1.5 inches are recommended (12, 31). Grass seeds contain relatively little stored food, consequently the percentage of emergence is reduced with increased depth of planting.

Rate of Seeding. When used alone, slender wheatgrass is sown at rates of 10 to 20 (usually 15) pounds of seed per acre (12, 28). Inasmuch as the species is a prolific seeder, thin stands or strip plantings may be expected to thicken if allowed to seed. Thickening by vegetative extension is slower with this grass than with such species as bromegrass and western wheatgrass.

When sown in rows for hay or seed production, 2 or 3 pounds of seed per acre suffice (2).

Mixed Seeding. Since slender wheatgrass is rather short-lived, and a bunch grass usually not forming a complete soil cover, its use in mixture frequently is recommended. As noted in a preceding section, the virtue of slender wheat in a mixture is its relatively rapid growth from seed. It makes a growth the first year while the associated species are becoming established, and is later replaced by them (2, 6).

Not much variety of mixtures of forage plants is possible on western dry lands because of the limited number of species adapted to the region. Of the grasses, slender, western and crested wheatgrasses, and bromegrass are the main possibilities; of the legumes, alfalfa and sweet clover apparently are the only ones that merit consideration. Of the possible combinations involving slender wheatgrass, brome and sweet clover would seem to be the best associates. Such a mixture would combine a bunch grass with a sod farmer, and a legume for soil improvement; the grasses would furnish spring and fall grazing, while the clover would be more productive during the summer months; sufficient variety would be supplied to satisfy the animal palate.

Brome-slender wheat and brome-slender wheat-sweet clover mixtures have been used to a limited extent in Alberta with success. In the first case, 7 pounds of seed of each grass was sown per acre; in the second, 5 pounds of each was used. In both cases, the bromegrass spread at the expense of the other species, and ultimately approached a pure stand (39). A similar mixture of brome and slender wheatgrass is reported to have given good results in Saskatchewan, yielding hay at the rate of 2 tons per acre after being down 6 years (24).

Hanson has suggested a mixture for the mountain grazing lands of Colorado. Growing conditions in the mountains probably are generally better than out on the plains, but the mixture nevertheless merits consideration. It is as follows: crested wheatgrass, 4 to 5 pounds per acre, slender wheatgrass 5, bromegrass 5, bulbous blue-grass 3, yellow sweet clover 2, totaling 20 pounds per acre (10).

Mixtures of slender wheatgrass and sweet clover, slender wheat with either crested wheat or brome, or both, and mixtures of slender wheat involving western wheatgrass have been suggested (2, 6, 28). In practice, mixtures to be used must be determined by the purpose of the planting, availability and cost of seed, and local soil and climatic conditions. No rigid rule can be prescribed.

Care after Seeding. The usual protective measures should be observed, i.e., exclusion of grazing animals until the plants are established. In a favorable year, some grazing probably can be done in the fall of the year of seeding. Discretion should be exercised with respect to grazing slender wheatgrass, particularly young stands, when the ground is wet and soft. It will always be more susceptible to trampling injury than a sod-forming species.

When weeds appear in abundance, high clipping once or twice during the first season is beneficial. This always should be done before the weeds have produced seed. When a nurse crop is used, it should be removed early in the summer to relieve the competition with the young grass plants. Usually this means cutting a cereal nurse crop before the grain is ripe. On clean land, and with a favorable season, a fair hay crop may be harvested, the first year. At Redfield, South Dakota, after a very wet spring, slender wheatgrass produced 1.7 tons of hay per acre the year of seeding. Seedings of bromegrass and crested wheatgrass did not produce a hay crop under the same conditions (8).

Regulated grazing, perferably deferred and rotated, will be helpful in maintaining slender wheatgrass pastures. Since the capacity for aggressive vegetative extension is lacking, provision must be made for the occasional maturity of a seed crop if the cover is to be maintained or increased.

Hay meadows which have become unproductive cannot readily be rejuvenated by cultivation, as are the sods of western wheatgrass and brome. Manuring is helpful (36) and may be feasible under some circumstances.

## GRAZING

Slender wheatgrass falls considerably short of being an ideal pasture grass, and as noted in preceding sections, is generally most useful in mixture with other forage species.

Seasonal Productivity. It has been noted under "Habits of growth" that slender wheatgrass is one of the earliest of the native grasses to start growth, in the spring, and that the date of its renewal coincides approximately with that of bromegrass. Further positive statements have not been seen. It is inferred from the discussions of the species that it is most productive in the spring, that it is inferior to bromegrass in constancy of production throughout the season, and that it is similar to crested and western wheatgrasses in becoming dormant during the hot dry weather of mid-summer. Moomaw (22) states that it shows marked ability to recover after growth has been checked by drought. However, it showed the effects of drought much more than either bromegrass or crested wheatgrass. Nelson (23) observed that some aftermath was produced in October after a September drought. Ten Eyck (31) states that it starts rather slowly in the spring and ceases growth early in the autumn. He also remarks that it is superior to brome in tolerance of cold and drought. His comments appear to be somewhat in disagreement with the general consensus of opinion, which is due, perhaps, to the fact that he was dealing with Kansas conditions.

Resistance to Grazing and Trampling. No positive statement has been seen relative to the tolerance of slender wheatgrass to grazing. Presumably it has not shown either inferiority or superiority sufficient to warrant comment. As has been noted in a preceding section, the resistance of pure stands to trampling is relatively low. The bunch habit of growth with bare interspaces, leaves it susceptible to trampling injury. Careful management of grazing therefore is imperative on wet land or land that is inclined to blow. Association with a sod-forming species is highly desirable.

Carrying Capacity. Slender wheatgrass has not received much consideration at the experiment stations as a pasture grass, and consequently, there are few comparative studies reported. It is inferred that the carrying capacity of pure stands is relatively low in the Northern Great Plains. At Dickinson, North Dakota, clipping experiments designed to simulate grazing showed slender wheatgrass to be less productive than crested wheatgrass, bromegrass or the native prairie. Assigning crested wheat a value of 100, the relative yields of brome, the native prairie, and slender wheat were 86, 77, and 62 respectively (on the basis of air-dry weights) (37).

Tinline (34) reports an experiment in pasturing sheep at Scott, Saskatchewan. The pasture values of sweet clover, alfalfa, winter rye, and slender wheatgrass were compared. The four pastures furnished respectively the equivalent of 774, 435, 345, and 593 days of pasturage per acre for one sheep. The sweet clover, however, ranked low in terms of gains in weight by the animals. In terms of cash value per acre, the following figures are given: sweet clover, $6.25; alfalfa, $3.25; winter rye, $2.50; and slender wheatgrass, $4.25. These calculations apparently were made on the basis of pasture days without regard for the gains produced. The experiment ran for only one season and the results admittedly are not conclusive. It demonstrates, however, that slender wheatgrass may serve as a valuable pasture plant under some conditions. Furthermore, it constitutes additional evidence indicating that this plant is most productive and valuable northward.

Palatability and Nutritive Value. In the western mountain grazing lands, where slender wheatgrass attains its greatest importance as a range plant, it is highly esteemed for its palatability and nutritive value. Sampson (27) states that it furnishes choice feed for all kinds of stock. Cattle and horses relish the plant and thrive on it throughout the year. The foliage, in common with that of the other wheatgrasses, cures well on the ground on the dry western ranges. Sheep are not so fond of the mature leafage, but take the seed heads readily. Forsling and Dayton (7) agree with Sampson, and remark that "sheep relish the grain, which, if mixed with more succulent feed, aids in putting on hard, substantial fat". Hanson (10) notes that the forage is palatable and nutritious, especially to cattle and horses, but that sheep are not so fond of it. In the palatability tables of range plants prepared by the Forest Service, the wheatgrasses are given a rating of 80 (the relative maximum) for horses and cattle throughout the year. For sheep, they are rated at 40 to 50 for summer grazing and at 80 for ground-cured winter forage.

Palatability is a relative value, depending on the nature of the associated species. A given plant may be the first choice of grazing animals in one region, and avoided in other localities where more palatable species are present. The observations noted above, and the ratings of the Forest Service are based on the western mountain and inter-mountain native ranges. They do not strictly hold when slender wheat is compared with other cultivated grasses.

At the Dickinson substation in North Dakota, bromegrass was eaten close to the ground while slender wheatgrass was scarcely touched in a pasture composed of plots of the two species. The kind of livestock grazing the pasture is not specified. Presumably cattle were used. The statement is made that "it is common knowledge that a slender wheatgrass is better adapted to hay, than to pasture" (35). In a later report from the same station, the statement is made that "slender wheatgrass aside from furnishing a good quality of hay has very little to recommend it in results from this section" (33). Apparently this remark was based on both palatability and yields. At the Williston substation in North Dakota, slender wheatgrass is said to be far excelled by brome in both quantity and quality of pasture (26). Christ states that when orchard grass and timothy are available, livestock prefer them to the wheatgrasses (3).

In a palatability test of sixteen grasses at the Ontario Agricultural College, slender wheatgrass was the least palatable of all to both cattle and sheep (29). The various grasses were rated in percentages, i.e., the most palatable species was rated at 100, and the others graded relative to it, as determined by the amount of forage of each species consumed when all were equally available. On this basis, slender wheatgrass was rated at 37 for cattle and 26 for sheep. The results of this test show other surprising features. Tall oat grass and orchard grass, both of which are generally stated to be of low palatability, received high ratings, the former being rated at 100 for sheep, and the latter at 100 for cattle. Bromegrass was rated 81 for cattle, and 80 for sheep; timothy, 87 for cattle and 92 for sheep. Crested wheatgrass was not included in the series. These results demonstrate the marked difference in relative palatability of plants in different situations. Soils and climate, as well as the identity of the associated species, probably are influential factors.

Despite the results of the Ontario tests, palatability would not seem to be a valid basis for discrimination against slender wheatgrass in the plains region. There is ample evidence that stock will take it readily when it is one of the major sources of feed.

The high nutritive quality of slender wheatgrass has been noted above (7, 10, 27). Without taking space here to quote analyses, it may be stated, however, that slender wheatgrass pasturage tends to run slightly lower in nutritive value than bromegrass, crested wheatgrass, and the native prairie vegetation in the Dakotas. Data on chemical composition are reported by Westover and his associates (37) and by Hopper and Nesbitt (11). Extracts from their data may be found in the report on bromegrass issued by this office.

## HAY

Slender wheatgrass finds its greatest favor and usefulness as a hay plant. Farmers and stockmen of the northern plains have used it largely as a supplement to their wild hay acreages, and have left the burden of pasturage to the native ranges. The constantly increasing demand for grasses adapted to both hay production and pasture has in the past been most nearly met by bromegrass, and recently, by crested wheatgrass. Only in hay production does slender wheatgrass rank high in adaptability to the needs of the region.

Yields. The quantity of hay produced by any species is subject to many variable factors, and sweeping conclusions should be made with caution. Genetic strains, soils, topography, cultural methods, age of stand, general climatic conditions and local seasonal conditions represent some of the more significant variables. A conclusion referring to a given locality is more reliable than a more general one, but the heterogeneity of soils and fluctuations of weather render even local conclusions far from infallible.

Actual yields of hay may be as high as 4 tons per acre under very favorable conditions. Piper (25) states that yields ordinarily are from 1.5 to 2 tons per acre. This figure undoubtedly is too high as an average for the northern plains region of the United States. The data compiled by Westover and his associates (37) indicate that 1 ton per acre is a fair yield on the plains of the Dakotas, Wyoming, and Montana. Yields of less than 1 tone are quite general.

As noted before, slender wheatgrass appears to be better adapted northward. Yields run somewhat higher in the Canadian prairie provinces. Kirk (16) stated in 1929 that it "still is regarded as the best cultivated hay crop for general use in the three prairie provinces". Tinline (34) reports average yields of more than 2 tons per acre at Scott, Saskatchewan. His records cover 8 years, in two of which the total rainfall was less than 7 inches. Kirk (18) reports yields averaging approximately 1 ton per acre at Saskatoon, Saskatchewan. His records cover 5 years, some of which were unusually dry. Slender wheatgrass yielded an average of 1.41 tons per acre over a period of 6 years at the Sandpoint substation in northern Idaho (3). This is in a region originally forested, which indicates climatic conditions somewhat more humid than on the plains.

In comparison with bromegrass and crested wheatgrass in the Northern Great Plains, the yields of slender wheatgrass tend to be slightly lower according to the data compiled by Westover (37). He states in summary that "in comparative tests extending over a period of about 15 years crested wheatgrass has generally yielded somewhat better than bromegrass or slender wheatgrass. Both bromegrass and slender wheatgrass frequently yield more the first two or three years, after which the slender wheatgrass tends to die out and the bromegrass becomes sod-bound, while the crested wheatgrass continues to produce satisfactorily, provided moisture conditions are favorable."

Yields of slender wheatgrass are relatively, as well as actually higher in more favorable situations. Ten Eyck (31) states that it outyields bromegrass where the two are equally well adapted. At Guelph, Ontario, it gave the highest yields of hay of 16 grasses tested for 6 years (25, 29).

Palatability and Nutritive Value. Slender wheatgrass hay is generally regarded as palatable and nutritious. It is commonly reported to surpass timothy in nutritive value (11, 23, 27). Analyses naturally show marked variations in chemical composition, since composition, as well as tonnage, is influenced by genetic and environmental factors. Hay made from this species commonly runs slightly lower in protein and higher in fiber than western wheatgrass, crested wheatgrass, and bromegrass. Individual analyses sometimes indicate that slender wheatgrass is markedly inferior (37), but when averages are assembled the differences are not great (9, 11, 18). The tendency toward lower protein and higher fiber contents in this grass probably is correlated with its tendency to be stemmy, since protein occurs mostly in leaves, and mature stems are largely fiber. Cutting at the proper time (when in flower) apparently is of greater importance with this species than with some others. Delayed cutting results in unpalatable woody hay of low feeding value. Furthermore, dangerous amounts of ergot are much more likely to be present in hay that has gone past the flowering period (32).

## SEED

Slender wheatgrass has very good seed habits, which fact accounts in some measure for its introduction into cultivation. Authorities generally agree with Piper's statement (25) that "seed is produced in abundance and is easily harvested". The percentage of viability also is fairly high. The seeds are relatively large, being three-eighths to one-half inch long, and resembling small oat grains. They are distinctly larger than the seeds of crested wheatgrass. Their size, weight, and surfaces are such that they are readily handled by machines. Threshing and seeding offer no particular difficulties. The standard weight per bushel is 20 pounds.

The plants normally flower in late June-July, and the seed are ripe in late July or August (3, 22, 23). Seed crops sometimes are severely damaged by ergot or rust, to both of which the grass is rather highly susceptible. The greater part of the commercial seed supply is harvested in the Canadian prairie provinces.

There is a paucity of quantitative data on seed yields, despite the many references to the grass in the literature. Piper (25) found no authentic reports in this connection and leaves the question unanswered. He evidently overlooked the reports of the Dickinson substation in North Dakota (21, 22). Data given therein indicate that slender wheatgrass produces approximately the same quantities of seed per acre as do bromegrass and crested wheatgrass. The record of seed yields for three years, as tabulated by Moomaw, is given below:

| Grass | Method of seeding | Yields seed per acre (pounds) 1921 | 1922 | 1923 | Average |
|---|---|---|---|---|---|
| Bromegrass | Rows | 143 | 314 | 163 | 207 |
| " | Close drills | 180 | 265 | 174 | 206 |
| Slender wheatgrass | Rows | 125 | 308 | 49 | 161 |
| " | Close drills | 160 | 661 | 173 | 331 |
| Crested wheatgrass | Rows | 151 | 348 | 252 | 250 |
| " | Close drills | 233 | 459 | 217 | 303 |

The plats from which these data were obtained were sown in 1920. The yields perhaps are not strictly comparable, inasmuch as the stands originally were rather poor (21), and the bromegrass thickened more in subsequent years than the other two species. Nevertheless, they give a general idea of the results to be expected in the western part of the Dakotas in favorable years (the annual rainfall was slightly above the mean in each of the four years, 1920-'23). It will be noted that the individual yields vary widely from the 3-year averages.

Christ (3) has recorded some agronomic data on grasses at the Sandpoint substation in northern Idaho. Although conditions there are not strictly comparable with those of the Great Plains, his figures on seed yields are not without interest. From plantings in rows made in 1931, the following yields were obtained in 1933; bromegrass--1663, crested wheatgrass--863, and slender wheatgrass--640 pounds of seed per acre. Climatological data for 1933 are not given, but it is evident that conditions were very favorable for these species, particularly bromegrass. The mean annual rainfall at the Sandpoint station is 27.23 inches.

Slender wheatgrass seed is stocked by many dealers, but as has already been mentioned, they do not usually specify varieties. Since the demand for this seed has never been great in this country, supplies probably are limited. If large quantities were to be used in a reseeding program, it doubtless would be prudent to make provision a year in advance for harvesting additional supplies of seed. A suddenly increased demand without compensating supplies would in all probability cause a marked advance in prices. Dealers now list the seed at prices ranging from 20 to 30 cents per pound.

## CONCLUSIONS AND RECOMMENDATIONS

In the reports from this office dealing with bromegrass and crested wheatgrass, the compiler has taken the liberty to point out some of the difficulties and limitations in the culture of grasses in the Northern Great Plains. A few comments in this connection may bear repeating here, since the body of this report, like the others, tends to emphasize the positive aspects of the grass under discussion. It must be recognized that no forage plant, drought resistant though it may be, is consistently dependable in that region. Both private experience and the records of the experiment stations testify to the fact that seeding is a precarious undertaking, and that a certain inevitable proportion of failures will result. They show further that the forage produced by established stands declines to almost negligible amounts in unfavorable years, and that occasionally wholesale death of plants results from drought.

Every species has certain optimum requirements of moisture, nutrients, and temperature. These factors are expressed in the climatic conditions, soils, and topography. Slender wheatgrass is favored by cool climates, as indicated by its better growth northward and at higher elevations westward; it prefers rather light and slightly alkaline soils; and in general, it finds the soil and moisture conditions most conducive to good growth on valley bottoms, lower slopes, and benchlands. Success in growing the grass will be generally correlated with the fulfillment of these conditions.

It is evident in the light of this report and those dealing with crested wheatgrass, western wheatgrass, and bromegrass, that no cultivated grass offers much promise on the drier ridges and uplands in the Northern Great Plains. On these areas, the only feasible practices would seem to be those directed toward the conservation, improvement, and extension of the existing native prairie vegetation.

As has been intimated in the foregoing pages, slender wheatgrass is, on the whole, less valuable than the three other grasses under consideration. It tends generally to be less productive, lower in nutritive value, less palatable, shorter lived, and more susceptible to injury by drought. Its favorable points are its good seed habits, more vigorous initial growth from seed, the production of a good quality of hay, the fact that seed are commercially available, and that the grass is more or less known to farmers of the region. Its bunch habit of growth is a virtue in that stands do not become sod-bound, but this habit renders it less resistant to trampling and less able to maintain itself in closed stand.

Pure stands of slender wheatgrass, therefore, will be of most value when harvested for hay. Since the plants tend to die out after 4 or five years, provision must be made for reseeding. This entails considerable trouble and expense, and the loss of the crop for at least one year when the usual methods are followed. Reseeding might be accomplished by allowing the seed of the remaining plants to ripen, after which the area could be pastured after the manner of the deferred and rotation system of grazing. This makes use of the activities of the animals in scattering the seed and trampling them into the ground.

However, the effectiveness of this method of thickening a stand apparently has never been demonstrated for slender wheatgrass in the plains region. It can be offered merely as a suggestion, based on the success of the system in maintaining and improving native ranges.

In view of the growth habits and characteristics of slender wheatgrass, its greatest usefulness generally will be realized by sowing it in mixture with a sod-forming species, such as bromegrass or western wheatgrass. Because of its more vigorous initial growth it may provide some forage while the other species are becoming established, and in subsequent years, its presence may retard the thickening of the sod-farmer, and thus delay the advent of the sod-bound state. Furthermore, mixtures generally make a better quality of forage. They satisfy the animal's craving for variety, and thepalatability of each component is enhanced by the presence of the others. On the whole, there seems to be little justification in this country for establishing slender wheatgrass in pure stand under any circumstances, except for seed production.

## SUMMARY

The cultivation of slender wheatgrass, which was the first native American forage grass to be domesticated, was begun in Manitoba, Canada, in 1885. It appears always to have been held in higher esteem in the Canadian prairie provinces than in the plains region of the United States.

Slender wheatgrass is a bunch grass, with practically no capacity for vegetative spread except through tillering and enlargement of the bunches. When in flower, the foliage attains a height of 2 to 4 feet.

The seedlings make a relatively rapid growth the first year. Under favorable conditions, some fall pasturage or a light hay crop may be produced. Established plants start growth with the earliest of the native species in the spring, make their maximum growth in May and June, flower in July, and mature in August. Stands begin to deteriorate through dying out after 4 or 5 years. No cultural procedure, other than reseeding, is of much value in restoring such stands to their former condition.

More breeding work apparently has been done with this species than with any other perennial dry-land grass. Breeding work is facilitated by the fact that the flowers normally are self fertilized. Most of the efforts to develop improved strains have been carried out in Canada. Strains reputed to be superior have been introduced under the names of "Grazier", "Fyra", and "Mecca".

Slender wheatgrass is the most widely distributed native member of the genus Agropyron. In the plains, it is found as far south as Kansas, but attains its best development northward from Wyoming to the Canadian prairies. It seems to be completely hardy to cold, and ranks high in endurance of drought. Its root development is inferior to that of crested wheatgrass and bromegrass, and in general it seems to be somewhat more susceptible to drought injury than those two species.

It is best adapted to light, well drained, sandy soils. It will grow in soils containing moderate amounts of alkali, but is distinctly less tolerant in this respect than western wheatgrass.

There are no specific cultural practices to be discussed. Thorough preparation of the seed bed is desirable before planting. Seeding unprepared cultivated land offers some promise of success, but its practicability still is rather doubtful.

Spring (about May 1) is usually recommended as the best time for seeding in the northern plains. Seeding also may be done in the fall (about September 1) if moisture conditions are favorable.

The seeds are handled readily by a drill and are best planted in that manner. Planting should be from 0.5 to 1.5 inches deep, the greater depths being dictated by dryness of the top soil. Fifteen pounds of seed per acre is the rate usually recommended. When sown in rows for hay or seed production, 2 to 3 pounds of seed per acre are required.

Slender wheatgrass may be advantageously seeded in mixture with other forage species. Since it is a bunch grass, it is best combined with a sod-former such as bromegrass. Sweet clover is the most useful legume for inclusion with grass mixtures in the northern plains.

After seeding, the usual protective measures should be observed until the plants have become established. It may be necessary to clip the weeds once or twice during the first year. If the season is favorable, the area may be grazed moderately in the fall without appreciable harm. Because of the openness of stands due to the bunch habit of growth, grazing should be very carefully controlled when the ground is wet and soft. Regulation, and provision for occasional seeding will be necessary to maintain the grass under grazing, since it is poorly adapted to spread vegetatively. Pure stands probably will gradually deteriorate, even with the best of care.

Slender wheatgrass is most productive of pasturage in the spring and early summer. It is usually a few days later than crested wheatgrass in the spring, and like the latter, tends to become dormant in mid-summer. Some aftermath may develop in the fall after rains.

The available data indicate that the carrying capacity of slender wheatgrass pastures is relatively low in the Dakotas.

In palatability and nutritive value, the grass ranks high, particularly on the ranges of the western mountain area, but it seems to be slightly excelled in these respects by crested wheatgrass and bromegrass.

When cut for hay, the yields are perhaps slightly lower than those of bromegrass and crested wheatgrass. The differences in average production are not great. One ton of hay per acre is a fair yield in the Dakotas, Wyoming, and Montana. The Canadian data indicate that yields are somewhat better northward.

In palatability and nutritive value, the hay, like the green forage, ranks high, but on the average is slightly excelled by bromegrass, crested wheatgrass and western wheatgrass. Because the hay is rather stemmy, it is important that it be cut at the time of flowering or very soon thereafter. When allowed to stand longer, the stems become woody and unpalatable, and dangerous amount of ergot may appear.

The seed habits are generally good. Seed is produced in quantities comparing favorably with the yields of other grasses, and is easily harvested and threshed. Yields may run above 600 pounds of seed per acre, but probably average about one-third of that amount.

Seed are commercially available at prices ranging from 20 to 30 cents per pound.

The conclusions to be derived from the literature are that slender wheatgrass has merits that justify its use in the Northern Great Plains, but that, on the average, it ranks below crested wheatgrass and bromegrass in productivity, feeding value, length of life, and resistance to drought; consequently, it is less generally useful than those species for permanent plantings in the region. Pure stands will be of most value when harvested for hay. On the whole, the grass can be utilized most effectively in mixture with other forage plants, of which one is a sod-forming species.

LITERATURE CITED

(1) Alberts, H. W.
1933. Forage crops in the Matanuska region, Alaska. Alaska Agr. Expt. Stas. Bul. 11.

(2) Anonymous
1933. Suggested soil-improving and erosion-preventing crops for land taken out of wheat, corn and cotton, west of the 97th Meridian. Division Forage Crops and Diseases, Bur. Plant Indus.

(3) Christ, J. H.
1934. Reseeding burned-over lands in northern Idaho. Idaho Agr. Expt. Sta. Bul. 201.

(4) Cowan, J., and Burnett, E. A.
1916. Farming practice in the Sand Hills section of Nebraska. Nebr. Agr. Expt. Sta. Bul. 156.

(5) Dillman, A. C.
1910. Breeding drought resistant forage plants for the Great Plains area. U. S. Dept. Agr., Bur. Plant Indus. Bul. 196.

(6) _____
1913. Grasses for canal banks in western South Dakota. U. S. Dept. Agr., Bur. Plant Indus. Circ. 115.

(7) Forsling, C. L., and Dayton, W. A.
1931. Artificial reseeding on western mountain range lands. U. S. Dept. Agr., Circ. 178.

(8) Garver, S.
1927. Forage crops and their culture in northern Nebraska and the Dakotas. U. S. Dept. Agr. Farmers' Bul. 1511.

(9) Griffiths, D., Bidwell, G. L., and Goodrich, C. E.
1915. Native pasture grasses of the united States. U. S. Dept. Agr. Bul. 201.

(10) Hanson, H. C.
1930. Pastures for spring and fall grazing in mountains of Colorado. Colo. Agr. Expt. Sta. Bul. 360.

(11) Hopper, T. H., and Nesbitt, L. L.
1930. The chemical composition of some North Dakota pasture and hay grasses. N. Dak. Agr. Expt. Sta. Bul. 236.

(12) Hurtt, L. C.
1934. Instructions, range reseeding. North Rocky Mt. Forest and Range Expt. Sta.

(13) _____
1935. Regrassing Montana dry farms. North. Rocky Mt. Forest and Range Expt. Sta. Applied Forestry Notes 69.

(14) Kearney, T. H.
1924. The choice of crops for alkali lands. U. S. Dept. Agr. Farmers' Bul. 446 (rev.)

(15) Keim, F. D., Beadle, G. W., and Frolik, A. L.
1932. The identification of the more important prairie hay grasses of N ebraska by their vegetative characters. N ebr. Agr. Expt. Sta. Research Bul. 65.

(16) Kirk, L. E.
1929. The improvement of western ryegrass, Agropyron tenerum Vasey. Sci. Agr. 10:239 - 250.

(17) _____
1932. Crested wheatgrass. University of Saskatchewan. Coll. of Agr. Extension Bul. 54.

(18) _____, Stevenson, T. M., and Clarke, S. E.
1934. Crested wheatgrass. Dom. Canada Dept. Agr. Pamphlet 157 (new series).

(19) Love, L. D., and Hanson, H. C.
1932. Life history and habits of crested wheatgrass. Jour. Agr. Research 45:371 - 383.

(20) Malte, M. O.
1920. Breeding methods in forage plants. Proc. West. Canada. Soc. Agron. 1:64 - 75.

(21) Moomaw, L.
1922. Report of the Dickinson Substation 1920-1921. N. Dak. Agr. Expt. Sta. Bul. 160.

(22) _____
1925. Dickinson Substation report for 1922 and 1923. N. Dak. Agr. Expt. Sta. Bul. 189.

(23) Nelson, A., and Nelson, E.
1903. The wheatgrasses of Wyoming. Wyo. Agr. Expt. Sta. Bul. 59.

(24) Oakley, R. A.
1907. Miscellaneous Papers V. The culture and uses of bromegrass. U. S. Dept. Agr., Bur. Plant Indus. Bul. 111.

(25) Piper, C. V.
1934. Cultivated grasses of secondary importance. U. S. Dept. Agr. Farmers' Bul. 1433 (rev).

(26) Ruzicka, C. H.
1922. Williston Substation report for the years 1914 - 1920. N. Dak. Agr. Expt. Sta. Bul. 158.

(27) Sampson, A. W.
1924. Native American forage plants. John Wiley and Sons, Inc., New York.

(28) Semple, A. T., et al.
1934. A pasture handbook. U. S. Dept. Agr. Misc. Publication 194.

(29) Squirrell, W. J.
1929. Hay and pasture crops. Ontario Dept. Agr. Bul. 347.

(30) Stewart, P. H., and Gross, D. L.
1935. Permanent and temporary pastures for Nebraska. Nebr. Agr. Coll. Extension Circ. 102.

(31) Ten Eyck, A. M.
1911. Grasses. Kansas Agr. Expt. Sta. Bul. 175.

(32) Thompson, O. A.
1921. Edgeley Substation report 1914 - 1920. N. Dak. Agr. Expt. Sta. Bul. 145.

(33) Thysell, J. C.
1919. Ninth annual report of the Dickinson Substation. Report of the Dickinson Substation for the years 1914 - 1918 inclusive. N. Dak. Agr. Expt. Sta. Bul. 131.

(34) Tinline, M. J.
1924. Hay and pasture crops in northwestern Saskatchewan. Dom. Canada Dept. Agr. Bul. 40 (new series).

(35) Waldron, L. R.
1919. Eighth annual report of the Dickinson Substation. Report of the Dickinson Substation for the years 1914-1918 inclusive. N. Dak. Agr. Expt. Sta. Bul. 131.

(36) _____
1919. Bromgrass, slender wheatgrass and timothy. N. Dak. Agr. Expt. Sta. Circ. 24.

(37) Westover, H. L., et al.
1932. Crested wheatgrass as compared with bromegrass, slender wheatgrass, and other hay and pasture crops for the Northern Great Plains. U. S. Dept. Agr. Tech. Bul. 307.

(38) Wheeler, W. A., and Balz, S.
1906. Forage plants and cereals at Highmore Substation 1904 - 1905. S. Dak. Agr. Expt. Sta. Bul. 96.

(39) Wilson, M. L.
1932. Dry farming in the north central Montana "Triangle". Mont. Agr. Coll. Extension Bul. 66.